Regenerative medicine: Healing the body by healing itself

As a general rule, the most successful man in life is the man who has the best information

aheadoftheherd.com

The advances made in stem cell therapy and regenerative medicine over the past few years have been astounding. While scientists still have a ways to go in understanding how stem cells - the building blocks of life - function in order to heal diseases that up to now have only been handled by drugs and surgery, the field is opening to new discoveries practically every day, making regenerative medicine one of the sweetest spots for Ahead of the Herd investors to be in right now.

What is regenerative medicine?

Webster's defines it as "the restoration or the growth by an organism of organ or tissue, that has been lost, removed or injured." The field of regenerative medicine focuses on the replacement or revival of tissues and organs, using all of the different technologies available: drugs, biopharmaceuticals (any drug extracted from a biological source), medical devices and cells.

All regenerative medicine seeks to repair/replace damaged cells or tissues in order to restore normal function, thus slowing or even stopping the effects of the pathology the patient is suffering from. Stem cell research plays a central role in regenerative medicine, since stem cells can be transformed into any of the body's 200 cell types and theoretically, live as long as the body does. Stem cells can repair diseased or damaged cells and lead to new cell growth. Stem cells can also be guided through a series of steps into cells that produce proteins or hormones required by the body.

A brief history

Regenerative medicine was first mentioned in a 1992 article which stated: "[A] new branch of medicine will develop that attempts to change the course of chronic disease and in many instances will regenerate tired and failing organ systems." However, the more widespread use of the term is attributed

to William Haseltine, the founder of Human Genome Sciences, a biopharmaceutical company, who recognized that stem cells sourced from human embryos have a unique ability to differentiate (split) into all the different cell types in the human body, a process known as pluripotency. This ability opened up a huge new potential to develop regenerative therapies across a broad swath of the medical spectrum.

Early successes included the first transplant of a windpipe (or trachea) at a hospital in Barcelona in 2008, and the transplant in 2014 of a 1.3 by 3.0-millimeter sheet of retinal pigment epithelium (cells that line the body surface) that were differentiated into the eye of an elderly woman suffering macular degeneration.

The history of regenerative medicine cannot be split (no pun intended) from the history of stem cell research, which goes back much further.

In the 1880s the discovery that some cells have the ability to produce other cells led to attempts to fertilize mammalian eggs outside the human body. About 20 years later scientists found that some cells could generate blood cells, and then in 1968, the first bone marrow transplant was performed. Other key developments in the history of stem cell research, courtesy of explorestemcells.co.uk, include:

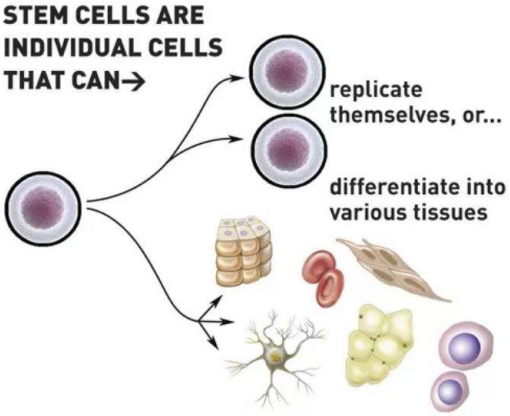
- 1978: Stem cells were discovered in human cord blood
- 1981: First in vitro stem cell line developed from mice
- 1988: Embryonic stem cell lines created from a hamster
- 1995: First embryonic stem cell line derived from a primate
- 1997: Cloned lamb from stem cells
- 1997: Leukaemia origin found as haematopoietic stem cell, indicating possible proof of cancer stem cells

Even more important events followed shortly thereafter, including the 1998 discovery of the first embryonic stem cells, and a decade later, the finding that manipulating mouse tissues could produce different cell types e.g. cells from bone marrow could produce liver cells. This meant that scientists could potentially exert a higher amount of control over how stem cells divide and proliferate.

Stem cells: What's the big deal?

To understand this question, one needs to be acquainted with some basic biology. Every cell has the same set of DNA, but different genes are active in each - say a nerve cell and a blood cell. Embryonic stem cells are considered the "purest" type of stem cell. Formed right after conception, embryonic stem cells have the ability to transform into any other type of

cell in the body - they are pluripotent. By contrast, adult stem cells can only split into the different cell types from the tissue they originated from, which limits their usage. Also, embryonic stem cells can be relatively easily grown in a lab, while adult stem cells are rare in mature tissues, so isolating them is challenging, and ways of expanding their numbers have yet to be worked out, explains an excellent stem cell primer from the National Institutes of Health. However one important advantage of adult stem cells is they are less likely to be rejected by the body, versus embryonic stem cells, which means the patient may not have to go on immunosuppressive drugs to help the stem cells to survive.



In 2006 a sort of hybrid stem cell was invented, the induced pluripotent stem cell (iPSC), which are adult stem cells that have been genetically reprogrammed to become like an embryonic stem cell. Although more research is needed to determine the exact differences between iPSCs and embryonic stem cells, scientists are finding them useful for developing drugs and modeling diseases, with the hope of using them more in transplantation medicine.

The concept of stem cell therapy is fairly basic, in that stem cells are injected into the diseased tissue (say a dying brain) allowing for healthy replacement cells to grow. Stem cells can also make repairs to damaged cells and replace missing elements such as hormones. e.g. insulin.

Benefits of stem cell therapy

Compared to drug therapies or surgery, stem cell therapy is a far more natural and less invasive way of treating diseases, ailments and the inevitable effects of the aging process. An example is stem cell therapy used in the treatment of arthritis and other forms of joint pain. Performed as an outpatient procedure, recovery times are minimal, and daily routines can be maintained. Side effects from the use of opiates, sleeping pills and other potent pharmaceutical drugs are no longer relevant.

Applications: Everything from teeth to cows

Over the years stem cell therapy and regenerative medicine have combined to produce a number of fascinating applications. Below are just a few recent ones:

Heart disease

It is extremely encouraging to see stem cells being researched to treat heart disease, which along with cancer is the most likely fatal disease to strike people as they age past 50. Nearly 2,600 Americans die of cardiovascular disease each day, or one person every 34 seconds. Small animal studies involving embryonic stem cells, cardiac stem cells from the heart, bone marrow-derived stem cells, cells that give rise to the interior lining of blood vessels, and umbilical cord blood cells have all been investigated as possible sources for regenerating damaged heart tissue. A few studies have also been carried out in humans during open-heart surgery, demonstrating that stem cells injected into injured heart tissue can improve cardiac function.

Cancer

Stem cells have been shown to replace cells in the bone marrow that can cause cancer. St Catharines Standard tells of a patient who tried stem cell therapy following a second round of chemotherapy to fight myeloid leukemia. At Juravinksi Hospital and Cancer Centre she received a stem cell transplant while also receiving immunosuppressive drugs to aid in the cells' survival. After 100 days, no signs of cancer were found in her body, and the disease has been in remission for five years.

Researchers at Dartmouth's Norris Cotton Cancer Center are currently devising strategies to target glioma stem cells in order to treat a particularly aggressive type of brain tumour that has one of the worst cancer survival rates. The tumors are attacked by identifying a pathway that is essential for maintaining glioma cancer stem cells, reports Science Daily.

Alzheimer's disease

Just this week Celltex Therapeutics Corp. and Texas A&M's Institute for Regenerative Medicine announced an intellectual property licensing deal involving research on a potential stem cell therapy for Alzheimer's disease. According to the Houston Chronicle, the therapy involves a substance known as exosomes produced by a type of stem cell isolated by researchers. Exosomes are thought to be able to cross the blood-brain

barrier, unlike most drugs, which is why many experimental drugs to treat Alzheimer's disease often fail.

Diabetes

Type 1 diabetes is thought to be an excellent candidate for stem cell therapy because patients who suffer from the disease are lacking a single cell type known as the beta cell. Researchers are looking at either using stem cell derived cells as "factories" that produce beta cells, or using stem cells to support beta repair. Stem cells can also be guided through a series of steps into cells that produce proteins or hormones required by the body. These stem cells can be guided to produce either progenitor cells which then develop into glucose responsive cells when transplanted into a medical device in the body or more fully differentiated cells which produce insulin on an immediate basis when transplanted into a medical device within the body. A number of investigators are working on these technologies. The goal is to have the body produce insulin normally so that the patient does not have to rely on daily insulin injections to control blood sugar levels.

Teeth

Stems cells aren't usually thought to be useful in dentistry, but that is beginning to change thanks to new research. Emi Shimizu, a researcher at Rutgers School of Dental Medicine, has just received a $1.5 million grant to pursue research into how stem cells could be used to regenerate dental pulp rather than removing it - the usual course of action in performing a root canal. As described by Medical Xpress, "her work involves isolating patient stem cells, which can be drawn from skin or hair, and cultivating them to form the vascular network that comprises the nervous system of dentin, the hard bony tissue beneath tooth enamel."

In Britain researchers are working on a new type of filling that could prevent root canals in the first place. The fillings contain materials that enable them to stimulate stem cells in the pulp tissue beneath the bony dentin layer, enabling the decayed pulp to be restored. If the new fillings are used early enough, the dead pulp could regenerate, eliminating the need for a root canal.

There is also promising research into using stem cells to actually regenerate teeth, which could eventually prevent a common dental procedure: filling a hole in a tooth caused by a cavity. A team of bioengineers at King's College, London discovered that they could boost

teeth's natural healing ability by mobilizing stem cells in the dental pulp. Tapping into an earlier-discovered molecular pathway that is essential for stem cell development in other parts of the body, the scientists realized that exposing damaged teeth to drugs that stimulate the pathway could also encourage the activity of stem cells in dental pulp. Their theory has been tested on mice and rats, but not yet humans.

Livestock

The use of stem cells of course is not limited to the human body. While beyond the scope of this article, one interesting use of stem cells could see the breeding of specialized traits in cows. Science just reported that after a couple of decades of trying, scientists have finally managed to derive embryonic stem cells from cows and keep them in a pristine state without dividing. Access to the bovine stem cells could result in "designer breeds" that produce more milk, more tender meat, or animals that are more resistant to diseases.

The market for regenerative medicine/ stem cell therapies

Science aside, the market for regenerative therapies is huge. In 2016 regenerative medicine generated $17 billion in revenue, and is expected to triple to $50.5 billion by 2025. The North American regenerative medicines market holds 39% of global market share, according to a recent report.

The global stem cell market is growing equally rapidly, with a compound annual growth rate of 10.5% between 2017 and 2025, states another forecast. According to that report, the market was valued at $5.2 billion in 2016 and is expected to reach $13.7 billion in 2025. It predicts induced pluripotent stem cells will be the fastest growing market due to their applications in regenerative medicines, drug screening, disease modeling and organoid (an organ produced in vitro) generation.

Conclusion

The new and exciting field of regenerative medicine is ripe for investment opportunities for those able to separate the wheat from the chaff, so to speak. While stem cell research promises plenty of potential cures, there have also been failures and many charlatan companies whose treatments are little more than placebos. The New York Times noted that "enthusiasm for stem cells sometimes outstrips the science." Other obstacles include producing consistent and high-quality therapies, receiving federal approval (President George W. Bush prohibited the use of federal funds to create

new embryonic stem cell lines in 2001, a decision that was reversed by Obama) and persuading insurers to cover treatments.

On the other hand, most of the research in regenerative medicine is being led by academics and done by small companies. The amount of research and clinical trials that need to be done often involves too much capital to take them all the way to FDA approval, meaning they will be looking to either partner with larger companies or be bought out. This is when the real money is to be made by investors.

I've been keeping my eye on the regenerative medicine space for the past several years and I see it as one of the most potentially rewarding fields for Ahead of the Herd subscribers. Is regenerative medicine, and a potential investment opportunity, on your radar screen?

If not, maybe one should be.
Richard (Rick) Mills
aheadoftheherd.com

Sign up for Ahead Of The Herd's free **highly acclaimed newsletter.**

***